The Future of the CBERS Program: A View from Brazil

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Introduction

Earth observation technology can undoubtedly be considered as one of the great successes of the use of advanced information technology for the improvement of mankind. The capabilities provided by satellite imagery, digital maps, and associated information have transformed our ability for understanding the forces that shape the geographical space. In developing nations, many of whom lack strong traditions on cartography and mapping, these technologies have proven essential for developing public policies on issues such as deforestation assessment and management, urban planning, agricultural production and environmental assessment.

Given this general scenario, this paper examines the role of the CBERS program in promoting the use of geoinformation technology for the benefit of Brazil and China. It also analyses the prospects for the CBERS program as an instrument for international cooperation. For this purpose, we will try to answer five general questions:

- Why is CBERS a public good?
- What are the appropriate data policies for CBERS for Brazil and China?
- What is the international scenario in remote sensing?
- What is the place of CBERS in the world of remote sensing?
- What is the best long-term policy for CBERS data production and distribution in the international market?
- What is the strategic value of the CBERS program?

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CBERS: A Satellite for the Public Good

In order to fully understand the potential of CBERS, we must first ask the question: *Where would CBERS data make a significant contribution to the remote sensing community?* There are three main situations[2]:

(a) *When there is a need to routinely monitor a large area consistently, reliably and/or independently.*

Both for Brazil and China, their large and remote areas can only be monitored in a consistent basis using remotely sensed imagery. Our countries have great challenges in the areas such as agricultural production, forest management, environmental protection, water supplies, energy production, and coastal zones monitoring, that can only be supported by a satellite that provides systematic coverage of all our territories.

(b) *Where there is a need to gather information rapidly about events whose location and timing are unpredictable.*

This includes natural or human-induced disasters, as well as military reconnaissance, situations in which the capacity for gathering information from any place within a short period in essential. These requirements imply in the use of different sensors for the same satellite, and the capability of large area and off-nadir viewing to reduce revisit time. These requirements have been included in the design of CBERS-1 and 2 and improved in the design of CBERS-3 and 4.

(c) *Where there is a need to gather information from location where access is prevented or is difficult.*

Satellites have clear advantages over other means of obtaining information in issues such as monitoring large deserts, the ocean's surface and tropical forests. Areas such as the Amazon Rain Forest can only be monitored effectively by remote sensing satellites.

[2] This discussion is adapted from concepts presented in MacDonald[2002].

(d) *Where there is a need for cost-effective cartographic mapping using satellite imagery as the basic information to update maps or produce new ones.*

Remote sensing images can be used to update old maps or to reduce time and cost factors associated to the production of new maps. For example, Brazil has large areas in its territory where detailed and updated maps are not available.

All of these situations are examples of uses that primarily serve the "public good" [MacDonald, 2002]. In other words, the customer base for the CBERS satellite is very concentrated on the government sector. This implies that CBERS should be seen as a provider of infra-structural data that supports government actions. Therefore, we conclude that CBERS is a "public good", and that its data and distribution policies should be primarily aimed at making government action more efficient.

Data Policies for the Public Sector: A Comparison

Remote sensing data, such as CBERS, is a good example of information produced by governments for the whole of society. In general, the public sector is the most important producer of data in most nations, including the United States, Brazil and China. This information includes scientific, environmental and statistical data which is fundamental for both public and private companies. The importance of public-sector data for the society is such that governments face a great dilemma: *what is the appropriate data policy for public sector information?*[3]

There are two very different ways of solving this problem. In the United States, public information is considered a valuable national resource; the economic benefits to society are maximized when government information is made available inexpensively and as widely as possible. In Europe, government agencies treat their data as a commodity used to generate short-term revenue. They control the use of public-sector information and aim to recover the costs of

[3] The following discussion follows the arguments of Weiss [2002].

the collection and creation of such data. In practice, the result of such policies is that an equivalent set of public data costs in Europe much more than in the US.

As an example, a LANDSAT-7 image covering an area of 180 x 180 km2 costs US$ 600. A set of 9 SPOT-5 images covering the same are will cost US$ 36.000. Therefore, the SPOT-5 images cost almost 40 times more then one LANDSAT-7, even though both satellites are funded by the public sector.

Which of the two approaches is more efficient? The European Commission's Directorate General for the Information Society commissioned a study from PIRA International on the *Commercial Exploitation of Europe's Public Sector Information* [PIRA International, 2000]. The PIRA study attempts to quantify the economic potential of public sector information in Europe and the extent to which it is being commercially exploited, and suggests policy initiatives and good practices. PIRA states:

> *"Cost recovery looks like an obvious way for governments to minimize the costs related to public sector information and contribute to maximizing value for money directly. In fact, it is not clear at all that this is the best approach to maximizing the economic value of public sector information to society as a whole. Moreover, it is not even clear that it is the best approach from the viewpoint of government finances."*

The amounts of money involved are significant. PIRA distinguished between government investment in public sector information ("Investment Value") and the value added by users in the economy as a whole ("Economic Value"). PIRA estimated the investment value of public sector information for the entire European Union at 9.5 billion euros/year. The economic value was estimated at 68 billion euros a year. By comparison, the investment value for the United States is 19 billion euros/year and the economic Value is 750 billion euros/year. What is happening? For a public investment only 2 times bigger, the US is obtaining an economic return 10 times bigger than Europe.

Economic Potential of Public-Sector Information in Europe and US (in Euros)		
	EU	US
Investment value	9.5 billion	19 billion
Economic value	68 billion	750 billion

source: PIRA International (2000)

The PIRA study went on to observe that the European market would not even have to double in size for governments to more than recoup in extra tax receipts what they would lose by ceasing to charge for public sector information. The study concluded that there is compelling evidence about the benefits of adopting data distribution policies for public-sector information without copyright restrictions, charging only the cost of reproduction and removing all restrictions on its use by public and private sectors. Therefore, the cost recovery policies of individual agencies in Europe generate benefit for themselves, to the detriment of the economy at large [Weiss, 2002]. Similar studies have obtained the same conclusion [Lopez, 1996].

The conclusions of this study have important consequences for CBERS data and distribution policy. Since CBERS data serves primarily the public good and its main users are government agencies, it would very detrimental for these users to adopt cost-recovery policies, considering the very high costs of building and operating a remote sensing satellite. If CBERS images are available by charging only the cost of reproduction, maximum use of the information is ensured.

INPE and the Brazilian Space Agency have approved a policy for CBERS-1 and CBERS-2 that calls for the widespread dissemination of images collected over Brazil. CBERS images will be made available on Internet, free of charge to all users. Additionally, a high-quality image processing software and geographical information system developed by INPE (SPRING) is already freely available on the Web. This software enables users to process effectively CBERS for a large variety of applications. This policy will ensure that Brazilian users will have the maximum possible facilities for using CBERS data to the benefit of the society as a whole.

The New International Scenario on Remote Sensing

The initial impetus for the development of remote sensing in developing nations was based on international cooperation programs, such as the LANDSAT program. Looking at the international Earth Observation programs for the next 10 years, there is a definitive trend in USA and Europe to move these technologies to the private sector, and therefore increasingly view the developed world nations as paying customers of geoinformation technology.

The US LANDSAT program has been, over the last 25 years, a major source of data about the Earth. The data policy adopted by LANDSAT, which allows copying and distribution of images without restrictions and additional charges, has proven instrumental for earth observation data to reach a wide audience in the developing world. The LANDSAT program effectively provided the foundation for the establishment of the international Earth Observation research community. Unfortunately, the international data policy for the LANDSAT program will change substantially in the near future. The data policy to be adopted for LANDSAT-8 (the next generation Landsat) establishes a double-tier policy. Data of the interest of the US government (roughly 1/3 of the total scenes collected daily) will be available to local US costumers at the cost of reproduction. Data currently received by ground stations worldwide will be open to exploitation by the commercial US firm responsible for the Landsat-8 satellite. This situation puts those countries that have built large data archives of LANDSAT imagery, including Brazil and China, with the prospect of a much-increased data access fee and restrictions on data distribution.

In the case of the SPOT satellite, the current generation of satellites (SPOT-4 and SPOT-5) is already sold at commercial prices, out of the range of most costumers in developing nations. Furthermore, the French Space Agency (CNES) has announced that SPOT-5 will be the last satellite of the series. Future plans of an Italian-French cooperation call for a constellation of mini-satellites (500 kg): four radar satellites (built by Italy) and two sub-meter high-resolution optical satellites (built by France), under the Pleiades program. Because of their conception, the satellites in the Pleiades program will be limited in swath, with ground coverage on the order of 30 km, and they are focused on issues such as detailed cartographic mapping, military reconnaissance and emergency monitoring. The French and Italian governments have decided to concentrate on the high-resolution imagery market, to compete directly with satellites such as IKONOS and Quickbird. There are no plans for future SPOT-like satellites that would provide medium to high swath (100 to 800 km range) and systematic monitoring of all the Earth, such as CBERS.

CBERS in the International Market

We should now consider the place for CBERS in the international community. As shown above, it is likely that the cost of earth observation data produced by US and Europe for developing nations will increase significantly in the coming years. Furthermore, there will a reduction on the number of earth observation satellites for environmental applications. This transition represents a major opportunity for CBERS. By choosing an appropriate data distribution policy, CBERS could be an instrument for diplomatic, goodwill and indirect commercial gains in our relations worldwide. If China and Brazil adopt a public-oriented policy (similar to the current LANDSAT policy) for the international diffusion of CBERS images, CBERS has a significant chance of being used by other nations. An international network of CBERS ground stations would be established. Instead, if China and Brazil choose a commercial policy of cost-recovery for international users, we will face direct competition with LANDSAT-8 and SPOT-5 operators which are already established worldwide, and therefore our chances of success will be much smaller.

The Design of CBERS-3/4: Some considerations

It is now time to consider the consequences of the local and the international scenarios in the design of the next generation of CBERS satellites. Since CBERS-3 and 4 will be launched in the 2006-2010 timeframe, it is important to consider the perspective of the international space programs which are planned for the same timeframe or that will be available earlier. From the Brazilian perspective, the design of CBERS-3/4 has taken into account the following strategy:

- To provide a replacement for LANDSAT users, offering similar bands with improved radiometric resolution. As a result, the CCD instrument to be built by Brazil has 4 bands in 20 m spatial resolution with 10-bit radiometric resolution, including a short-wave infrared band.

- To improve the wide field imager sensor (AWFI), which has proven to be a valuable resource in CBERS-1 and will provide a unique capability for environmental assessments. The new WFI instrument in CBERS-3/4 will have 5 spectral bands (3 visible, 1 near infra-red, 1 short-wave infra-red).

INPE has also supported the proposal of a PANMUX sensor by CAST, which will have 5 meter panchromatic and 10 meter multi-spectral capabilities, as well as the improved IRMSS sensor, which will have 40 meter resolution. We believe that the combination of Chinese and Brazilian sensors on-board CBERS-3/4 will provide a completely viable alternative to the community of LANDSAT users, and will have sensors with equal or superior performance to India's IRS-P6 (ResourceSat).

Conclusion - CBERS as a Strategic Asset: It's not about Money

Looking at the points raised on proceeding discussions, the conclusion is that the CBERS program is an important strategic asset for Brazil and China. Unfortunately, the international cooperation perspective that was the foundation for Earth Observation programs worldwide is been substantially altered by unilateral decisions by the developed nations. Two prime examples are the US policy change in the LANDSAT program and the French decision to terminate the SPOT program. Large countries of the developing world which are heavily dependent on remote sensing data (such as Brazil and China) are suddenly faced with strong challenges.

We are very fortunate that, more than a decade ago, the governments of China and Brazil decided to cooperate on a long-term remote sensing satellite program. Such a program takes a long time to implement, but the results obtained thus far are a very positive indication that we are on the right track. Had we not started a decade ago to work together on an ambitious remote sensing program, our countries would be on a much more vulnerable position. We can now look forward to the challenge of providing our large remote sensing communities with adequate and cost-effective data in the decades to come.

By adopting adequate technical solutions and proper data distribution policies, China and Brazil can achieve two very important goals in the near future: (a) to provide to the large remote sensing of both countries sensors which can satisfy the requirements of most applications, and as a result make CBERS the satellite of choice for our users; (b) to enable CBERS to become a major instrument for international cooperation, paving the way for an increased presence of Brazil and China on the ever-growing area of international environmental policy-making.

Therefore, the CBERS program cannot be measured by economic indicators such as the amount of money generated by image sales. The CBERS program is not about money, but about the power and will of two cooperating nations to manage their territory independently of the policies of the developed world and to be able to contribute to the improvement of mankind.

References

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Disclaimer

The views expressed in this paper are those of the author and do not necessarily represent those of the Brazilian Government.

ANNEX : Perspectives for Similar Missions to CBERS-3/4

The following two tables present a comparison between the proposed configuration of CBERS-3/4 and that of LANDSAT-8 and IRS-P6.

TABLE 1 - COMPARISON BETWEEN CBERS-3/4 and Landsat-8

	CBERS-3/4	**Res (swath)**	**Landsat-8**	**Res (swath)**
Pan (Sharpen)	0,52-0,89 μm	5 m (60 km)[1]	0,5-0,68 μm	15 m (180 km)
Blue1	-	-	0,43-0,45 μm	30 m (180 km)
Blue 2	0,45 – 0,52 μm	20 m (120 km) [2] 73 m (866 km) [4]	0,45-0,515 μm	30 m (180 km)
Green	0,51 – 0,59 μm	10 m (60 km) [1] 20 m (120 km) [2] 73 m (866 km) [4]	0,525- 0,60 μm	30 m (180 km)
Red	0,63 – 0,69 μm	10 m (60 km) [1] 20 m (120 km) [2] 73 m (866 km) [4]	0,63 – 0,68 μm	30 m (180 km)
NIR	0,77 – 0,89 μm	10 m (60 km) [1] 20 m (120 km) [2] 40 m (120 km) [3] 73 m (866 km) [4]	0,845-0,885 μm	30 m (180 km)
SWIR 1	1,55 – 1,75 μm	40 m (120 km) [3]	1,56- 1,66 μm	30 m (180 km)
SWIR 2	2,35 – 2,55 μm	40 m (120 km) [3]	2,1 – 2,3 μm	30 m (180 km)

Legend: (1) PANMUX instrument with 8-bit resolution (China); (2) MUXCAM instrument with 10-bit resolution (Brazil); (3) IRMSS instrument with 8-bit resolution (China); (4) AWFI instrument with 10-bit resolution (Brazil). The LANDSAT-8 instrument has 12-bit resolution.

TABLE 2 - COMPARISON BETWEEN CBERS-3/4 and IRS P6

	CBERS-3/4	**Res (swath)**	**IRS**	**Res (swath)**
Pan	0,52 - 0,89 μm	5 m (60 km)[1]	0,62-0,68 μm	5.8 m (70 km) [5]
Blue	0,45 – 0,52 μm	20 m (120 km) [2] 73 m (866 km) [4]	-	-
Green	0,51 – 0,59 μm	10 m (60 km) [1] 20 m (120 km) [2] 73 m (866 km) [4]	0,525- 0,60 μm	5.8 m (24 km) [6] 23 m (140 km) [7] 65 m (700 km) [8]
Red	0,63 – 0,69 μm	10 m (60 km) [1] 20 m (120 km) [2] 73 m (866 km) [4]	0,62 – 0,68 μm	5.8 m (24 km) [6] 23 m (140 km) [7] 65 m (700 km) [8]
NIR	0,77 – 0,89 μm	10 m (60 km) [1] 20 m (120 km) [2] 40 m (120 km) [3] 73 m (866 km) [4]	0,77-0,86 μm	5.8 m (24 km) [6] 23 m (140 km) [7] 65 m (700 km) [8]
SWIR 1	1,55 – 1,75 μm	40 m (120 km) [3] 73 m (866 km) [4]	1,55- 1,70 μm	23 m (140 km) [7]
SWIR 2	2,35 – 2,55 μm	40 m (120 km) [3]	-	-

Legend: (1) PANMUX instrument with 8-bit resolution (China); (2) MUXCAM instrument with 10-bit resolution (Brazil); (3) IRMSS instrument with 8-bit resolution (China); (4) AWFI instrument with 10-bit resolution (Brazil). (5) P6 satellite (ResourceSat) – PAN instrument with 7-bit resolution; (6) P6 satellite (ResourceSat) – MSS instrument with 7-bit resolution; (7) P6 satellite (ResourceSat) – LISS instrument with 7-bit resolution; (8) P6 satellite (ResourceSat) – AWIFS instrument with 10-bit resolution.